SOME OBSERVATIONS ON THE BIOLOGY, INCLUDING MATING AND OTHER BEHAVIOUR, OF THE AUSTRALIAN SCORPION URODACUS ABRUPTUS POCOCK

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SUMMARY

Two species of scorpion of the genus *Urodacus* Peters 1861 are recorded from the Adelaide region of South Australia. These are referred to *U. armatus* Pocock 1888 and *U. abruptus* Pocock 1888. The different habitats of these two species are described. Observations on the behaviour of specimens of *U. abruptus* kept in captivity are recorded. This species has been observed to perform a mating procedure not previously described in the scorpions. After the typical stance of the promenade à deux is adopted the male has been observed to make a series of lunges or thrusts, in which he pushes himself through the "arms" or pedipalpi of the female. These acts appear to be an effort to turn the female backwards, upon her back, prior to copulation. Actual copulation was not observed.

Adults of this species of scorpion have been kept in captivity up to 22 months.

A supposedly parturient female of *U. abruptus* was observed, on very hot days in summer, to adopt an elevated stance, with the abdomen hyper-extended on the cephalothorax, with the telson drooping forwards. A similar, but less marked, attitude has also been observed in males of this species, under hot humid conditions. The purpose of this attitude is uncertain, but probably it has a respiratory and perhaps cooling function.

INTRODUCTION

The genus *Urodacus* Peters 1861 is confined to Australia, some 15 species being recognized. Two species of this genus occur in the vicinity of Adelaide, South Australia. The smaller darker species is the subject of the present paper, and will be referred to *Urodacus abruptus* Pocock 1888.[1] It lives in shallow tunnels in loamy soil, chiefly under stones, and is not uncommon in the Mount Lofty Ranges. The larger species is less common. It is lighter in colour, brown, and excavates tunnels in sand or sandy soils, these tunnels opening free to the surface. It will be referred to *U. armatus* Pocock 1888, described originally from a male specimen from Port Lincoln, South Australia.

RECORDED DISTRIBUTION OF U. ABRUPTUS

Urodacus abruptus Pocock 1888 was described from two females in the collection of the British Museum—"one ticketed Adelaide, the other merely New Holland." In 1893 Pocock referred again to this species, describing the male and stating, "This species seems to be common in South and South-east Australia. The type of the species (a dried specimen) came from Adelaide; but since it was described I have seen others in the Museum of Owens College, Manchester,

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[1] In the present paper I have followed the classification of Pocock (1888, 1893, 1898, 1902) rather than that of Kraepelin (1899, 1908, and earlier papers). The latter author regarded *U. novaehollandiae* Peters 1861 and *U. abruptus* Pocock 1888 as conspecific with *Isctonus manicatus* Thorell 1876. Although Kraepelin stated that he had come to this opinion after a study of Thorell's original specimens, there are so many gross discrepancies between Thorell's brief description and any *Urodacus* of which I am aware, that I consider it extremely unlikely that Kraepelin had Thorell's original specimens (from "Nova Hollandia") before him. Numerous errors by Kraepelin in both observation and interpretation are pointed out by Pocock (1891, 1898, 1902). Unfortunately it does not appear likely that Thorell's types can be recovered (Vachon 1954, personal communication). Both species in the Adelaide region correspond to Pocock's descriptions for *U. abruptus* and *U. armatus* respectively. The systematics of the genus *Urodacus* will be considered further in later papers.

which are ticketed Mount Lofty, South Australia, and Victoria." In 1898 Pocock reviewed the genus *Urodacus*. For *U. abruptus* he gave as localities "South and South eastern Australia, Adelaide, type (59.52); Ballarat and Bendigo, in Victoria (W. W. Froggatt); Cooma, Bathurst, Maitland, Yass, in New South Wales (W. W. Froggatt); New England District of New South Wales (J. Macpherson).

"Since I described this species the British Museum has received a very fine series of it from Mr. Froggatt and Mr. Macpherson from the localities mentioned above."

Glauert (1925) stated that this species extends in its geographical distribution from New South Wales through Victoria to South Australia. He states further: "Whether it enters Western Australia is doubtful. Kraepelin states that it occurs there, but I have failed to find it among the hundred or more specimens of *Urodacus* which I have received from all parts of the south of Western Australia. On the other hand, the *Urodacus*, so plentiful in the vicinity of Eucla, is *U. novae-hollandiae;* this suggests that *U. manicatus* (*U. abruptus*) does not reach the western boundary of South Australia." In the same paper Glauert recorded two specimens of this species from Kangaroo Island, South Australia.

PRESENT OBSERVATIONS ON HABITAT AND DISTRIBUTION

Urodacus abruptus is found in loamy soil in eucalypt forest, where it lives in shallow tunnels under fairly large stones. In the Mount Lofty Ranges of South Australia, where most of my field observations have been made, it is found in fair numbers at the edge of moderately dense forest of stringybark (*Eucalyptus obliqua*), or occasionally blue-gum (*Eucalyptus leucoxylon*), in preferably damp or slightly damp situations. I have also collected this species in the Grampians of Victoria, and at the western end of Kangaroo Island, South Australia.

Males may readily be distinguished from the females by the former having the dorsal surface of the abdomen dull grey, finely granular, whereas in the females the dorsal surface of the abdomen is darker, smooth and polished.

The specimens of this species (captured up to November 1953) in my collection are as follows:

Serial Number	Number of Specimens	Locality	Comments
S 3	6	Workanda Creek, National Park, Belair, Mount Lofty Ranges,, South Australia, 30th March, 1937	Parasitized by larval *Leptus* sp. (n. sp.) (Acarina Erythraeidae)
S 2	14	Mount Osmond (5 specimens) Workanda Creek (9 specimens) (Mount Lofty Ranges), April-May 1938	Kept in captivity. Some lived 2 months
S 4	4	Workanda Creek, 24 July 1938	Two mature; two juvenile
S 5	2	Waterfall Gully, Mount Lofty Ranges, 24 August 1938	One adult; one immature
S 7	1	National Park, Belair, 11 April 1939	
S 1	1	Cherry Gardens, Mount Lofty Ranges, 30 April 1939	Pectines removed experimentally. Lived some weeks. Was probably given insufficient water
S 8	3	Rocky River, Kangaroo Island, 29 December 1939	Two adult males; one immature
S 9	1	Workanda Creek, S. Aust., 13 December 1947	Mature. Lived 7½ months in captivity

Serial Number	Number of Specimens	Locality	Comments
S 10	1	Fish Falls, Grampians, Victoria, 4 January 1948	Mature female
S 11	1	Workanda Creek, 1 August, 1948	Dried carcase
S 12	1	Workanda Creek, 10 October 1948	Mature. Lived 4 months in captivity
S 27	1	Workanda Creek, 13 November 1948	Mature. Lived 9½ months in captivity
S 13	1	Workanda Creek, 22 May 1949	Mature. Lived 13 months in captivity
S 24	1	Workanda Creek, 23 October 1949	Mature. Lived 6 months in captivity
S 14	1	Workanda Creek, 30 July 1950	Mature. Lived 2½ months in captivity
S 25	1	Workanda Creek, 21 May, 1950	Mature. Lived 6 months in captivity
S 26	1	Workanda Creek, 12 November 1950	Lived 2 weeks in captivity
S 28	1	Workanda Creek, 18 February 1951	Parasitized by larval *Leptus* sp. (Erythraeidae), Acarina
S 15-18 19 A, B	6	Workanda Creek, July September, October 1951	Sexual activity noted. See detailed report below
S 20, 21	2	Workanda Creek, 16 November 1952	S 21 (female), lived 2 months. S 20 (male), still alive (September 1954), *i.e.*, has lived 22 months in captivity
S 22, 23	2	Workanda Creek, 30 August 1953	
S 43	6	Workanda Creek, 1 November 1953	Three specimens are still in captivity. Four mature, 2 immature

REARING EXPERIMENTS

It will be noted from the above data that since 1937 a number of attempts has been made to keep scorpions in captivity. So far it has been possible to keep adults alive up to 22 months in captivity. Since 1947 I have kept them in cylindrical glass pots, with overlapping (not sealed) lids. These pots are 15 cms. across by 10 cms. high and contain a little damp soil. Various insects and spiders have been given for food. So far no insect or arachnid that I have given them has been refused. I have fed them on moths, spiders, flies, beetles, etc. Generally moths or beetles are the most convenient. Of the beetles I generally give various species of Carabidae, *e.g. Clivina* sp., etc., or else *Adelium* sp. (Tenebrionidae). The scorpions appear to be able to distinguish an insect's (etc.) movement from that of another scorpion; as long as the insect moves at moderate speed the scorpion immediately seizes it, unless it is bloated with food or else the weather cold. The scorpions invariably sting their prey to subdue it as soon as it is captured, often stinging it twice in different sites before the struggles cease. If one scorpion walks over another, as often happens in the confined space of the pot, it is very rare for any evidence of resentment to be aroused. Skirmishes between these scorpions are rare. In its manner of stinging its prey immediately on capture *Urodacus abruptus* differs markedly from the large Philippine forest scorpion (*Palamnaeus longimanus* Herbst?) as described by Schultze. Schultze (1927) recorded that he had never seen this latter scorpion sting its prey—*e.g.*, cockroaches—in order to subdue it. The prey was held clear of the ground, and eaten while still struggling. Schultze stated that "I believe that the poisonous stinger is used only as a defensive weapon against its enemies." In its habit of stinging its prey in order to subdue it *Urodacus abruptus* resembles *Buthus occitanus*, as recorded by Fabre, rather than Schultze's species.

Urodacus abruptus can survive a considerable time without food. I have kept an adult male specimen in captivity for eight months without food, after which period it was given a housefly to eat. Since then it has been kept a further nine months without food, and remains at the time of writing (September 1954) active and plump, apparently quite healthy.When a group of scorpions is kept in captivity, even if both sexes are present, they generally live amicably. However, if food is not given they occasionally practise cannibalism. These scorpions are inactive by day, but become active at night. On inspecting the pot one morning one may find that one scorpion has disappeared, and a plump cannibal is finishing off the last of its fellow. I have not actually seen the beginning of such a meal, so am unable to say what circumstances precipitate it, or whether the sting is used in such an encounter, but in view of the general feeding habits of this scorpion it appears probable that it is. In such acts of cannibalism it is always one of the smaller specimens that succumbs. Usually the meal is almost over by the time it is discovered. I make a practice of counting up the number of scorpions in the pot at each observation. Usually the only parts of the vanquished that remain after such a meal are the pedipalpal claws (hands) and the vesiculus, with perhaps a few segments of the tail and the pedipalps, and part of the dorsal surface of the cephalothorax. The remainder disappears completely. When small beetles are given as food only the hardest parts of the insect remain after the meal, *e.g.*, the elytra and the exoskeleton of the thorax. Moths and spiders disappear completely, except the scales of the former. With moths the scorpion frequently commences to eat at the head. At the present time I do not usually feed the scorpions oftener than once per month. It is probably on account of this that I have more lately seen more frequent evidence of cannibalism. Even so, scorpions may remain in a pot for several months without feeding before one of the smaller specimens is eaten. There is no evidence that such cannibal meals commence in sexual activity, in fact, as remarked before the victims are immature specimens.

Water is needed more frequently by this species of scorpion. In the cooler months I generally give water about once per month. The floor of the pots is covered with a layer of earth, which is kept just damp. In the summer months water is given more often, usually about once per week. The water may be dropped on to the mouth parts by a dropper, or else pledgets of cotton wool soaked in water are placed in the pot. In the latter case, when the pot has become very dry, the scorpions will cluster around the pledget almost immediately, tearing at it with their chelicerae. They frequently give the appearance of eating the water rather than drinking it.

As yet parturition has not been observed in *Urodacus abruptus*, even though females have been observed in captivity with gross abdominal distension. Certain details of sexual behaviour have however been observed, and will be recorded in the following section.

SEXUAL BEHAVIOUR

Experiment S 15-19. On 29 July 1951 three scorpions were captured at Workanda Creek, National Park, Belair, South Australia. The two larger scorpions were placed in a small "wax vesta" tin. Nothing unusual was noted at the subsequent occasional examinations, until 10 September, a warm day, when many "scuffling" noises were heard emanating from the tin. On opening the tin it was found that the pair were holding "hands" as in a typical promenade à deux as described by Fabre. The pair were transferred to a glass pot as described above, and that manoeuvre separated them. On the morning of 11 September it was seen that the pair had resumed the promenade à deux position. No fresh observations could be made, and on the morning of 12 September the pair had separated again. On 13 September two fresh adult scorpions from Workanda Creek were

added to the pot. On 14 September further evidence of sexual activity was noted; a male had grasped a female askew, holding the passive female sideways on. On 15 September all scorpions were separate.

On 24 September I recorded: No further attempt at a promenade à deux has been observed. The scorpions do not appear to resent in any way one of their fellows climbing over them—this applies equally well to males and females. By day they are sluggish, but when one switches on the light at night to observe them they are at the alert, poised on their legs and with the telson up, walking or stalking around, manoeuvring the pectines delicately over the crumbs and lumps of soil in the pot, and demonstrating very clearly the tactile function of the pectines.

On 8 October 1951 I recorded: No further sexual activity has been observed. The five scorpions are in the pot on my study table, and are under pretty constant observation. The weather is warm today and perhaps this accounts for today's resumption of sexual activity. The soil in the pot has become rather dry. At 10.10 p.m. I noted: The couple rests for about half a minute, with fingers clasped (see fig. 1), and then the "orgasm" recommences. The male pushes the

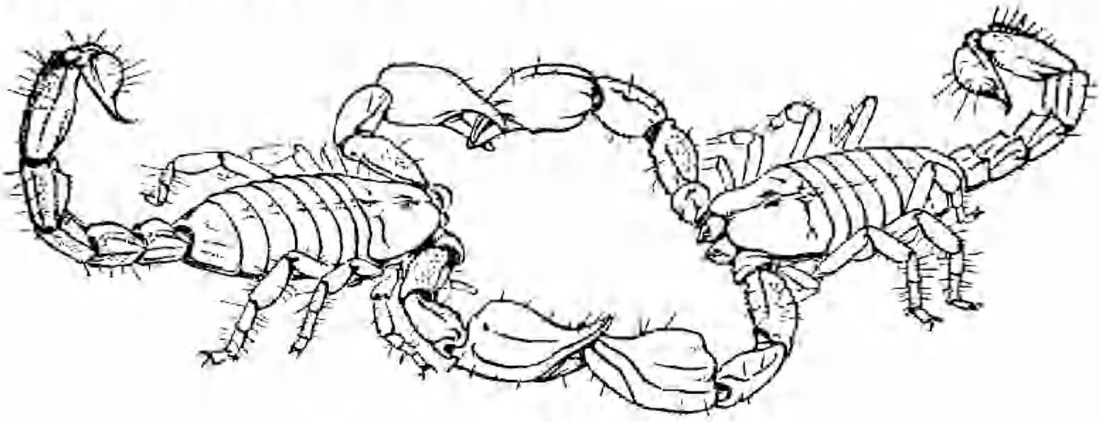

Fig. 1

Normal position of the promenade à deux in the scorpion *Uroducus abruptus*. Male to left. Note the more erect telson of the male, that of the female being semi-erect.

female against the glass side of the pot and wags his tail up and down in seeming attempts to climb through her "arms" and push his genital operculum against her mouthparts. The pectines move about seemingly to serve as tactile organs. His mouthparts work at the same time, the chelicerae being extended. His first legs are planted on her chelicerae, but she makes no effort at resistance or countermovement. He then pulls her backwards. The frenzy then starts again, the male's tail works vigorously, and at the next attempt he manages to climb further, in fact almost right through her arms (10.15 p.m.) (see fig. 2). One arm of the male then disengages, the male circles rapidly around, still retaining the grip of his other pendipalp (fig 3) until he faces the female again. The process then starts all over again. In the extreme position of the sexual lunge the pedipalpi of the female are twisted back behind the cephalothorax, and completely extended, so that the surface of the pedipalpi that is normally ventral faces dorsally and anteriorly (fig. 2). The mouthparts of the female remain quite impassive, and she remains no more than placidly co-operative during the whole of the process.

10.30 p.m.: The male nibbles at the female with one chelicera and then the other in quick succession, or with both simultaneously, at either her cephalothorax or the claws of her pedipalpi. Whilst doing this the male brandishes his

tail erect, and waves it about freely as though to heighten the "orgasm." The tail of the female remains flaccid, curled, usually rest on the soil, or else slightly raised, but it is never raised at more than 45° above the horizontal.

10.35 p.m.: The activity continues almost unceasingly. In one manoeuvre the male grasped the female by her wrong (contralateral) claw. The male soon corrected this. The female appears willing to go wherever the male will push or pull her.

10.37 p.m.: The male grabs the female's tail with one of his pedipalps and leads her around by it, pulling her tail over her cephalothorax. At this insult she opens her claws a little, but makes no effort to attack or resist the male, and she soon desists. The male soon after gets tangled up, grabbing anywhere at the female, but after some manoeuvring resumes the standard face to face position, again holding the female's pedipalpal "fingers" between his. Again the male attempts to climb through the female's "arms" on to her back, as in fig. 2.

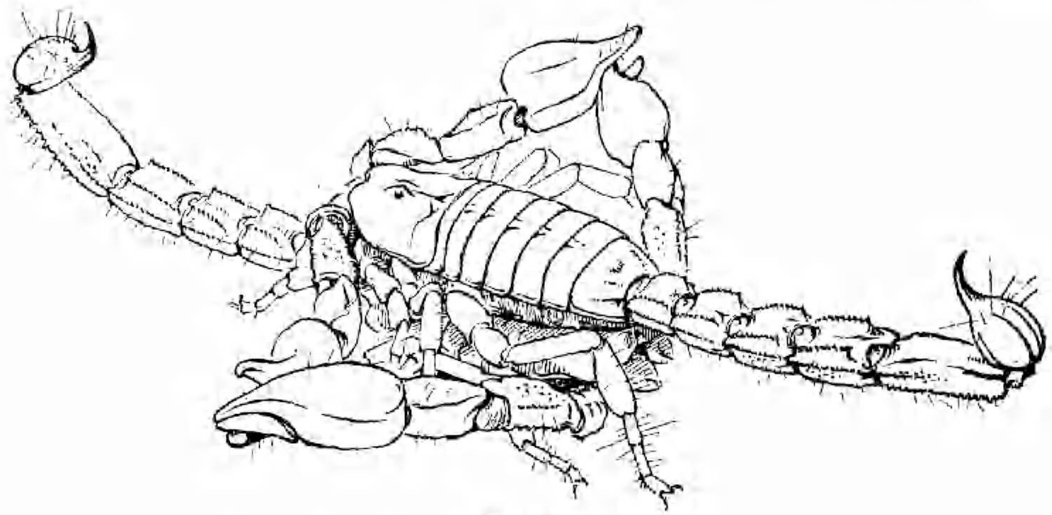

Fig. 2

The sexual thrust, in which the male forces himself through the pedipali of the female. The full depth of the thrust has not yet been reached.

10.41 p.m.: While attempting to climb through the female's "arms" the male nearly succeeded in pulling her over on to her back, using the hind end of her abdomen (mesosoma) as a pivot. Her cephalothorax was lifted clear of the ground, and sharply retroflexed upon her abdomen. The pair then returned to the standard face to face position (as in fig. 1), and the furious "kissings" and lunges started over again.

10.50 p.m.: An attempt was made at photography. The excessively bright lights necessary caused a cessation of sexual activity, which was never resumed.

OTHER BEHAVIOUR

These notes continue the narrative of the above group of specimens.

9 October 1951: Weather cooler. No further activity.

16 October: One female has died (not the one of the mating pair) from no apparent cause. Water was given. The surviving scorpions drank greedily.

On 27 October a further large female scorpion from Workanda Creek was added to the pot. By 25 November 1951 this female had died, for no apparent reason, and was removed from the pot. Water was given to the others, in the

form of a cotton-wool pledget soaked in water. The scorpions drank greedily, tearing at the cotton-wool with their chelicerae. On 16 December a spider was added as food. This was soon eaten by one of the scorpions. On 18 December it was observed that in the preceding two days one scorpion had been eaten by one of its fellows, and only the claws of the pedipalpi remained of the victim. On 21 and 29 December insects were given and were promptly eaten.

On 21 January 1951 all three scorpions appeared healthy. A moth was added to the pot. A male scorpion seized this immediately, stung it twice within a few seconds, and made off with it. But in doing so the male aroused the interest of a large female scorpion, which seized the moth from the male and carried it off. The male attempted two or three times to retrieve his meal from the female, but without success. The thwarted male attempted to pick a fight with the other male in the pot, but the latter maintained his dormant attitude and would not fight. Although stings were flourished in these encounters no scorpion actually used its sting on any other.

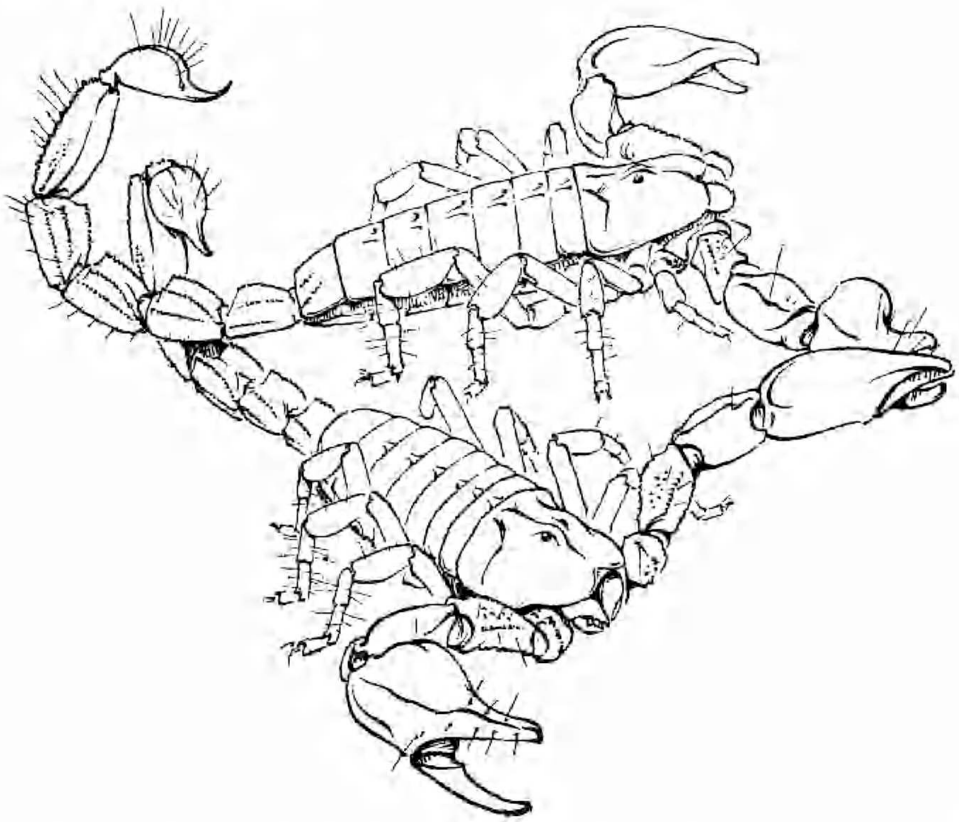

Fig. 3

The position shortly after the completion of the sexual thrust. The male has lost the grip with the left pedipalp, and is circling to resume the normal stance of the promenade à deux.

On 22 January 1952 a tented piece of bark was dropped into the pot. The female immediately retired into the cavity beneath this. On 21 March 1952 or shortly before this female died. Two males remained in the pot. These were fed and watered about once per month. On 16 October 1952 one of the males died. The other male remained healthy. On 19 September 1952 a freshly captured adult female had been added to the pot. No sexual activity was observed between these scorpions. Nothing unusual was observed for the remainder of the year. Food and water were given occasionally, and were always accepted.

On 23 January 1953 the female commenced to adopt a stance which had not been observed previously. My notes record: Female appears parturient, judging by the size of the abdomen. She elevates the posterior end of the abdomen, with the tail drooping forward (see fig. 4). She remains thus for an hour or so at a time, and then slumps to a flaccid heap on the soil. No attempt has been made to molest the male, or vice versa.

On 25 January she resumed the same position (as fig. 4) from noon until nearly 4 p.m. She remained flaccid on the soil until 6 p.m., then resumed the fig. 4 stance for three hours, after which she disappeared under the tented piece of bark. At 10 p.m. she emerged again.

This stance of elevation of the abdomen was resumed periodically but only on very hot days, and after 25 February 1953 was not observed. When she assumed her position she would climb on a piece of bark or a lump of soil in an apparent attempt to get as much elevation as possible.

On 31 March 1953 the female (S 18) died. By 13 April 1953 or shortly before the male (S 19A) died.

COMMENT ON THE SEXUAL BEHAVIOUR

I have not been able to find any record of the sexual lunges described above for *Urodacus abruptus* in the published descriptions of mating behaviour of scorpions. Millot and Vachon (1949), in an excellent review of the existing knowledge, state: "We owe the essential part of our knowledge to Fabre, in his Souvenirs Entomologiques . . . . On a single occasion he was able to catch a glimpse of ('entrevoir') the solution of the difficult problem of fertilization: the male, lifting his belly, slides under the female, the pectines interdigitating, the hands still constantly gripped. Well before Fabre, Maccary, in September 1809, had seen a male, after some initial failures, attack the 'forehead' of the female, turn her over on her back, and remain about five minutes upon her. In 1891 Brongniart and Gaubert reported that Marés, in Algeria, had surprised coupled scorpions, belly to belly, the pectines interdigitating." Millot and Vachon then proceed to discuss the mechanism of fertilization.

It is possible that the sexual lunges or thrusts recorded above for *Urodacus abruptus* were seen by Maccary in his "vaines tentatives (préludes)," for the Languedocian scorpion (*Buthus occitanus* (Amor.)). However, no more precise record than this appears to have been made previously.

The observations described above for *Urodacus abruptus* suggested that the male was attempting to push the female over onto her back, and in fact he nearly succeeded in doing this on one occasion during the observations. It is expected that in copulation the animals remain belly to belly, chelicerae to chelicerae, tail to tail, the male on top. The failure for actual copulation to occur may have been due to (1) disturbance from the bright lights in the attempts at photography; (2) inadequate facilities for the male to exert pressure on the female in his attempt to turn her on to her back. It is expected that in nature copulation normally occurs in the shallow tunnels in which these scorpions live. In such tunnels it would be possible for the male to exert considerable force with his legs braced against the sides. On the relatively flat earth surfaces in the rearing jars the male's legs were quite extended during the moments of maximal pressure in the sexual thrusts, and obviously the male was at the limits to which he could force himself.

The writer has since constructed an artificial tunnel of clear plastic, coming off a box of the same composition ("Perspex"). Some vertical scratches line the tunnel to aid the male in his bracing. It is hoped that the restricted space of this tunnel will provide suitable conditions for copulation to occur and be observed. As our scanty knowledge on this subject would indicate, opportunities to observe these phenomena are few and fleeting.

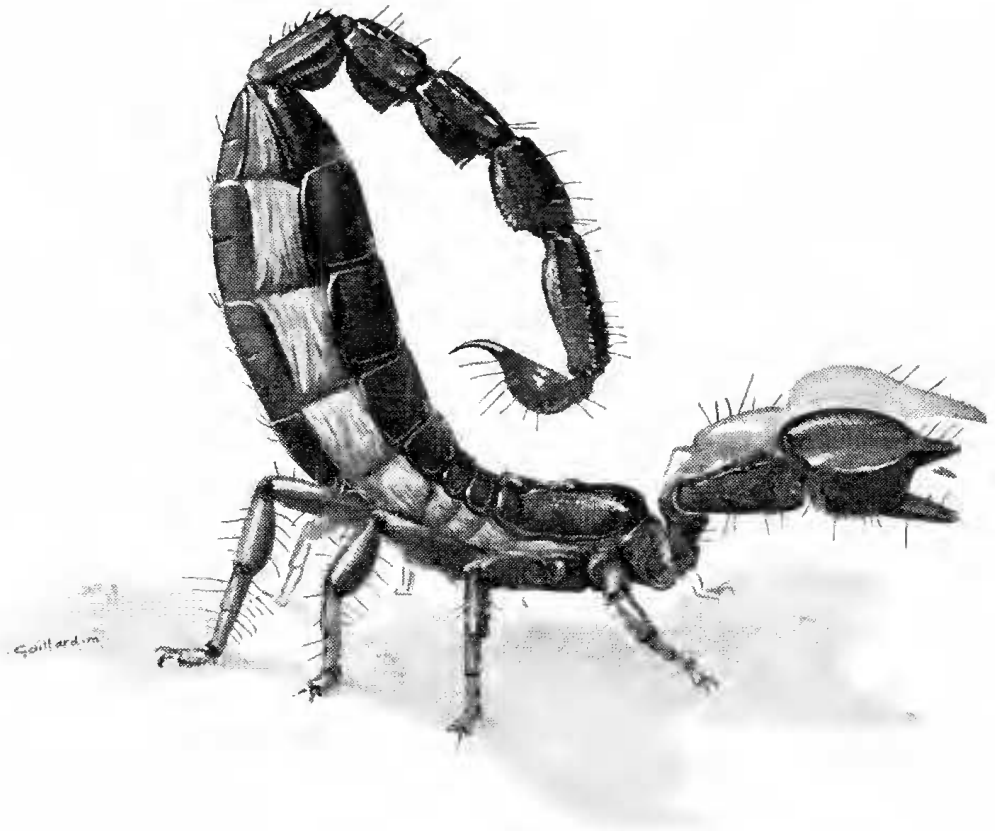

Fig. 4
The abdominal elevation seen in a female *Urodacus abruptus* in the heat of summer, under humid conditions.

It will be noted that in the mating dance of *Urodacus abruptus* the female keeps her tail comparatively flaccid—her tail is either loosely coiled behind her, semi-erect, or else lies flaccidly horizontal on th soil, loosely coiled. In this characteristic *U. abruptus* differs from other scorpions whose mating dances have been described, *e.g. Buthus occitanus* (see Fabre 1923), or *Buthotus alticola* (see Serfaty and Vachon 1950). In both of these latter species the female takes a slightly more active part in the mating dance, and in them the tail is described as remaining erect in both sexes.

It is of interest to note the "kissings" in *U. abruptus*—in which the male nibbles harmlessly at the "face," etc., of the female with his chelicerae. Since scorpions are but little changed in structure since Silurian times, it may reasonably be surmised that this and other sexual behaviour described extends back to a geological period of great antiquity.

COMMENT ON THE ABDOMINAL ELEVATION

It was at first thought that the elevation of the rear part of the pregnant female was indicative of imminent parturition. As however parturition did not ensue in the female described this surmise was rendered less likely. Schultze (1927) observed parturition in one female of the large Philippine forest scorpion (*Palamnaeus longimanus* Herbst?) recording that in this process it "held its body in a peculiar position, somewhat raised and bent or curved in the middle into a convex shape but with the chelipeds drawn up close to the body." This latter position is unlike the one described above for *U. abruptus*. I have observed males also of *U. abruptus* to adopt a similar attitude, on hot days in December 1953, when conditions in the pot were hot and humid. However in the male the attitude was less pronounced than in the female. It would appear most likely therefore that the stance described is an effort to lift the stigmata free from the humid layer of air and soil, when the scorpion's metabolism is increased by a hot environment.

ACKNOWLEDGMENTS

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